CHROMITES IN UNEQUILIBRATED ORDINARY CHONDRITES. C.E. Nehru[1,2], M.K. Weisberg[2] and M. Prinz[2]. [1]Dept. Geology, Brooklyn College, CUNY, Brooklyn, NY 11210, [2] Dept. Earth Planet. Sci., Amer. Museum Nat. Hist., New York, NY 10024.

Introduction Minor but significant amounts of chromian spinels and spinels are ubiquitous components of ordinary chondrites (OCs). Earlier studies of equilibrated OCs [1,2,3,4] have shown that chromite compositions and textural settings are related to the petrologic type of ordinary chondrite (H, L, LL) and their metamorphic history. These have been shown to be compositionally uniform in each meteorite type and within each meteorite. Consistency within individual OCs has been shown to be inaccurate [5,6] in studies of chromites from some type 4-6 OCs. More importantly, the extent of the variations in chromite compositions and textural settings from well characterized unequilibrated ordinary chondrites (UOCs) have been sparse in the literature. In particular, there have been no systematic studies that relate the chromites in UOCs to the progressive metamorphism scale as determined by thermoluminescence (TL) sensitivity. Is there a progression of changes in chromites from H3.4 -3.8, from L 3.3-3.8, or from LL3.0-3.8? Are chromites in UOCs sensitive to TL parameters? Are there differences between the chromite populations in low type 3 H, L and LL chromites? What is the significance of these results?

Present Study In an attempt to answer these questions we have studied 25 well-characterized H, L and LL UOCs. In addition, we have analysed chromites in 10 equilibrated OCs and used literature data [1,2,4] from 36 others. In total, data from 71 different OCs have been included in this study.

A list of the UOCs used (Table 1) span all the petrologic types, as determined by TL studies. Chromites from whole, as well as broken chondrules were studied. Isolated chromites that we studied from the matrices are indistinguishable from those in chondrules and may have been derived from broken chondrules. Individual chromites were analysed for 9 elements, by electron microprobe, and after appropriate corrections were recalculated to elemental proportions on the basis of 32 oxygens. These values were used to calculate the different ratios normally used in studying chromites. These include FFM, defined as (Fe+Mn)/(Fe+Mn+ Mg) and CRAL, defined as (Cr+V)/(Cr+V+Al) ratios.

Data and Discussion Plots of FFM vs. CRAL ratios of all chromites from H,L and LL UOCs are shown in Fig. 1. These data show that there is an increase in the average range of FFM and CRAL values from H3 to L3 to LL3. LL3s have the highest values, H3s the lowest, and the L3s occupy the mid-range as expected from the different oxidation states these meteorites display. There is considerable scatter in the FFM and CRAL values in each of the H, L and LL groups. Within each of the 3 groups there is no consistent pattern of variation of FFM and CRAL, from the lowest to the highest type 3s. This indicates that whereas the TL sensitive minerals show systematic changes, the chromites do not reequilibrate at these temperature ranges. This is due to the difficulty in equilibrating Cr and Al during subtle metamorphic changes. The FFM values were not able to reequilibrate without the corresponding equilibration of the Cr and Al.

FFM and CRAL variations of the equilibrated H, L and LL OCs (4 -6) are plotted in Fig. 2. It is seen that both FFM and CRAL ratios are variable, but there is more variation in the FFM than in the CRAL ratios. In addition, there is no correlation of the ratios with the progression of the equilibrated OCs from types 4-6. In general, the average CRAL ratios of the equilibrated OCs are slightly lower than those in the corresponding UOCs. The FFM variations are about the same in both equilibrated and unequilibrated OCs.

Occasional grains of Fe-Al-rich chromites are found in the UOCs. These show much lower FFM and CRAL ratios when compared with the more common chromites.When all of the data are combined it can be seen that the FFM and CRAL ratios of all chromites define a trend of increasing FFM with increasing CRAL.

Conclusions A textural and electron microprobe study of chromites from 25 UOCs shows that there is no correlation between the TL-based petrologic subgroupings H 3.4-H3.8, L 3.3 - L3.8 and LL 3.0 - LL3.8 and the corresponding chromite populations, in terms of their FFM and CRAL ratios. Chromites from the H, L and LL UOCs show more scatter than the higher petrographic types 4, 5 and 6, as expected. There is an increase in the average range of FFM and CRAL values from H to L to LL UOCs. There is some scatter in the FFM and CRAL values of chromites in types 4-6, but there is no correlation of these ratios when going from type 4 to 5 to 6. CRAL ratios of equilibrated OCs are slightly lower than those in the corresponding UOCs. There is incomplete homogenization of all chromite compositions, even at the higher grades of 5 and 6.

References: [1] Snetsinger K.G. et al. (1967) Amer. Min. 52,1322-1331.[2] Bunch T.E. et al. (1967) GCA 31, 1569-1582. [3] Yabuki Y. et al. (1983) Meteoritics 18, 426-428. [4] Johnson C.A. and M. Prinz (1991) GCA 55, 893-904. [5] Fudali R.F. and A.F. Noonan (1975) Meteoritics 10, 31-39. [6] Krot A.N. and A.E. Rubin (1993) LPSC XXIV, 827-828.

Table 1

Sharps	H 3.4	Bremervorde	H 3.8	ALHA 81031	LL 3.4
Frenchmans Bay	H 3.5	ALH 81024	L 3.3	Manych	LL 3.4
Willard	H 3.5	Inman	L 3.4	Chainpur	LL 3.4
Clovis	H 3.6	Khohar	L 3.6	ALHA 81030	LL 3.5
Brownfield	H 3.6	EETA 82601	L 3.8	ALHA 81032	LL 3.5
RKPA 80205,23	H 3.7	Krymka	LL 3.0	Parnallee	LL 3.6
PCA 82520,9	H 3.7	Semarkona	LL 3.0	Ngawi	LL 3.6
Dhajala	H 3.8	Bishunpur	LL 3.1		
Prairie Dog Creek	H 3.8	ALHA 76004	LL 3.2		

Fig. 1. Chromites from Unequilibrated Ordinary Chondrites

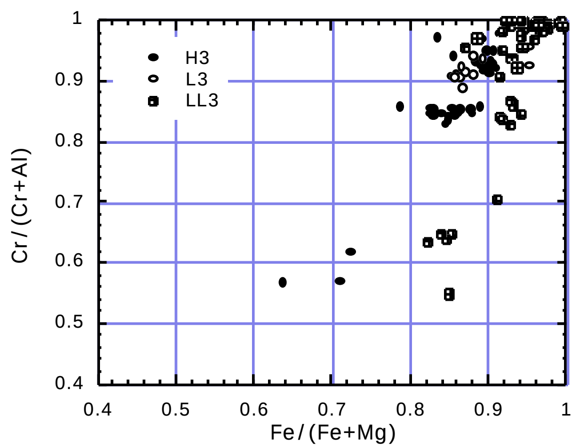

Fig. 2. Chromites from Ordinary Chondrites (Types 4-6)